Docking into the Digital Network:

Looking at Ports for a Sustainable Internet

George N. Ramírez

New York University

Sustainable Subsea Networks

Abstract

The environmental impact of information and communications technology, particularly from data centers, has become a topic of concern. However, the subsea telecommunications network--which carries almost all transoceanic Internet traffic--is largely omitted from carbon footprinting studies of the global Internet. Installing, maintaining, and repairing these cables requires a carbon intensive marine fleet, and many owners and operators have begun to develop sustainability initiatives. In turn, ports have also initiated projects that encourage ships to adopt sustainable practices. These efforts, we find, have occurred largely independent of one another. This article argues that we should look acrossports' and telecoms' sustainable developments, and find ways to facilitate conversations between the two industries. Drawing from interviews with port authorities, port organizations, and cable ship operators, I suggest that shore power and new energy carriers areleading solutions to reduce emissions. Voyage optimization and carbon capture utilization are offered as additional solutions towards decarbonization efforts. Kite systems and fuel cells are of particular interest for the subsea cable industry as they can be retrofitted to existing fleets. More bilateral connections are needed, however, to facilitate this uptake, leverage business relationships, and encourage vessels in their operation and supply chain to implement these technologies.

Introduction

Over the past two decades, scholars, journalists, infrastructure owners, and communities around the world have become concerned with the environmental impact of digital networks and telecommunications technologies (Vidal, 2017; Varghese, 2020; Patterson and Stripple, 2010; Turner 2014). In more recent years, attention has focused in on the electricity used and carbon emissions generated by internet infrastructure, especially the data centers that store the world's digital content (Ferreboeuf, 2019; Efoui-Hess, 2019; Makonin et al., 2022; Accenture Strategy, 2015; Cunliff, 2020). In light of rising sea levels, wildfires and heat waves, and the social effects of anthropogenic climate change, such concerns and associated research to empirically substantiate and mitigate the impacts and emissions of digital networks are ever more essential.

The backbone of our global internet, the subsea telecommunications cables that carry 99% of transoceanic data traffic, are installed, maintained, and repaired by a fuel-intensive marine fleet. A Life Cycle Assessment of a submarine cable system found that 7 grams of carbon dioxide equivalents are potentially released for every ten thousand gigabit kilometers (Donovan 2009). Yet this marine component of the Internet's carbon emissions, along with the potential mitigation measures it affords, remains almost entirely absent in research and popular discussions about digital media's climate impacts and solutions. While scholars and journalists have paid attention to emerging developments of 5G, last-mile infrastructure, and massive data centers, infrastructures such as boats and ports—although essential to global telecommunications—are rarely the subject of discussion. This is in part because subsea cables have also historically remained invisible, hidden under the sea and outside of public view. Moreover, even with their reliance on a marine fleet, subsea cables have a very small carbon footprint compared to data centers or last mile technologies and thus are often discounted in internet footprinting studies (Coroama et al., 2013; Malmodin et al., 2014). When included in these studies, researchers rarely dive into their specificity as marine technologies. Further, examining ports and subsea cables independently risks investing substantial funds into infrastructure and initiatives that ultimately do not function as effectively in practice.

This research seeks to remedy this oversight. Here, I provide an analysis of sustainable marine technologies and port developments that have high relevance to the subsea cable industry. I do so to argue that collaboration between port authorities and vessel carriers enables sustainable practices that are financially sound across both sectors. Some subsea cable operators are already engaging with these sustainable transitions. Take Global Marine, a subsea cable maintenance company, for example. CEO Bruce Neilson-Watts says, “It’s really difficult for our industry to change.” Not because people don’t want to, but “we are hamstrung because we sunk a lot of CAPEX into equipment and technology which is decades old.” For the last fifteen years, since the dot com and infrastructure bust and collapse around 2005, it’s been a customer’s market with low pricing. The “price point investment has not moved far enough” to be able to build new $90 million ships. However, they have been adapting multiple marine technologies to improve their decarbonization efforts. Global Marine’s fleet is shore power compatible for their frequent berths at Port Washington, US and Portland, UK, who have the accompanying infrastructure to power their vessels using the ports’ electric grid. Establishing and developing relationships with port terminal operators allows subsea cable companies to benefit from ports’ already existing sustainable technologies so maximize impact and minimize expenses.

Subsea cable companies like Global Marine are thinking across the sector to enable emissions reduction within their own industry. They also offer voyage optimization strategies for their customers, partake in recycling initiatives, and participate in energy efficiency initiatives shoreside. But the biggest polluters are the ships. For this reason, Global Marine has also taken up technologies of on-board continuous monitoring of the ship to maximize efficiency. Adopting these technologies can make carbon accounting for marine fleet emissions more accurate, which can improve environmental sustainability and provide a proactive approach to maintenance. In doing so, port authorities can also account for their own emissions and reach their sustainability goals more accurately.

Understanding the world of marine technologies is thus essential to understanding telecommunications today, and beyond this, understanding the emergent possibilities for sustainability is essential to mitigating the Internet's carbon emissions. The analysis and results in this paper aid in this understanding. Through conversations with port operators and cable companies, I found that onshore power supply and future energy carriers like hydrogen, ammonium, and methanol are leading the way for strategies to decarbonize marine transport. And yet developments are limited by the way the current system is set up: Port authorities are not regulatory agencies, so the only way they are able to encourage ship carriers to adopt these technologies are through incentive programs and concession agreements. I propose that telecommunication companies can enable similar agreements with their own vessels and others they use for their production, maintenance, and operation to further emission reduction efforts. Through cooperative relationships between port authorities and subsea cable vessel carriers, both industries can leverage each other’s resources to reach sustainability goals. This article also suggests voyage optimization and carbon capture as additional initiatives to reduce carbon emissions for marine vessels. Finally, power assistance technologies like kites and power cells can be adopted by ships that install and maintain the subsea cable network, especially since these technologies can be retrofitted to existing fleets and applied to cable landing centers. Although these changes minimize emissions, implementing them requires bilateral connections that incentivize all parties engaging with a vessel. Although there may not be a single universal solution for decarbonization, using multiple efforts across sectors at the same time can help. I hope that this research contributes to furthering sustainable information and communications technologies (ICT) and including ports as places that can support vessels toward the development of a more sustainable subsea cable network.

Literature Review

Ports and marine technologies expand our frame of analysis for sustainability strategies in the ICT sector. However, the environmental impact of ports and the Internet's marine basis is understudied. This paper addresses this gap in knowledge to practice a relational footprinting approach to media infrastructure (Pasek et al., forthcoming). In the current assessments and discussions about ICT and the environment, sustainability is generally tackled at the level of each specific telecommunications infrastructure: data centers have been the primary focus of sustainable development, but terrestrial networks, end-user-devices, and satellites have all received interest as well (Cubitt et al., 2011; Pasek 2019; Brodie 2020). In 2008, the US Environmental Protection Agency (EPA) reported that data centers were responsible for 1.5% of all US electricity consumption (US EPA, 2008). Since then, as increased data center use continues to impact the environment, many different approaches have been developed.

In the case of Microsoft Azure's service, environmental strategies are structured by a logic of accounting that attempts to achieve a carbon neutral standard. They have, like many others, sought to treat emissions as a fungible commodity that could be offset. But this can easily result in an increase in carbon emissions, since reducing emissions in one place while increasing in others does not necessarily have the environmental impact to cancel each other out.

Accounting is a step in a better direction, though holding companies accountable in ways that are spatially specific can develop a more environmentally sustainable politics (Pasek, 2019).

For telecoms to better attend to the increasing demand of being sustainable, the environment must be approached as combinations of material and immaterial resources that result from their natural, cultural, social, and political contexts. With cloud computing continuing to be dominated by hyperscalers, these companies gain increased responsibility for attributing value onto infrastructure and sustainability, and yet continue to consume a limited number of resources that are becoming increasingly scarce (Brodie, 2020). As ICT further develops, we should ask ourselves if existing business models are sustainable not only for the environment but for our global network. To address the "energy crisis of information," social and economic strategies must be implemented together (Cubitt et al., 2011). Media and communication studies provides an interdisciplinary framework to approach these concerns.

Within academia, scholars have for many years been producing compelling critical studies of digital infrastructures, ones that point out their environmental impacts and the ways that they are bound up with social, cultural, and political projects. These studies of infrastructure have the potential to add social strategies to the economic and technical approaches typically taken in the interest of sustainability. Following this literature, adopting an infrastructural disposition toward our global communications network helps us understand how audiovisual signal traffic is distributed within an array of material processes in relation to technological development, regulation, and use (Parks and Starosielski, 2015). In particular, approaching subsea cables as a media infrastructure provides a foundation from which to develop sustainable business models that are geographically specific and aware of their sociocultural impacts, particularly their environmental consequences.

The digital world is deeply material. To grasp how its infrastructures and byproducts come to fruition, information and communication technologies must be understood alongside their accompanying accounting practices. The framework of “data science” has the capacity to lay the foundation for partnerships between political ecologists and ICT experts for the study of climate change, environmental justice, and sustainable practices (Nost and Goldstein, 2022). Current policy debates surrounding sustainable alternatives for big data focus on changes in consumption rather than production, obfuscating accountability and governance. If the “global ecosystem” continues to be taken up as an approach to address climate change, nature must be reframed as a limited resource to best prepare for the future (Hogan, 2018). While there is no way to reverse the impacts of climate change, there is still the possibility of building a more generative politics. This essay's work to concretely assess the material realities of the Internet through subsea cables, port management, and marine technologies is one step in this direction.

Analysis of media infrastructures often, and by necessity, begins with the physical infrastructures that support signal traffic and communications networks. Scholars encounter and situate these massive, typically impenetrable systems within even broader sets of geopolitical struggles, corporate initiatives, and cultural milieus. At the same time there has been a close and careful commitment to the local, to the ways that infrastructures materialize within the social landscapes that they transact. This literature has focused on a variety of environmental issues. Beyond its thermal function for servers, water holds the capacity to reimagine how ICT comes to be managed, used, and felt. Relying on water forces us to frame innovation at multiple scales: from data and memory to subsea cables and marine technology. In the case of the US National Security Administration’s (NSA) Utah Data Center, water has been the way that activists have been able to articulate environmental and surveillance concerns against its use for illegal activities (Hogan, 2015). Bitcoin mining requires a substantial amount of electricity as well, a great amount supplied by subsidized hydropower in largely rural areas. Straining local electricity grids, mining operations have impacted the infrastructure in places like Chelan County, Washington, highlighting the asymmetric relationship that data centers have with natural resources and the labor force responsible for managing it (Lally et al., 2022). Geographic specificity is crucial to understanding the environmental consequences of ICT technologies.

While discussions about reducing the internet's carbon footprint tend to focus on electricity usage, taking the full range of media's infrastructure into account brings with it new points of inflection, especially in the geographies of marine transport. When the ICT sector has taken up questions of their carbon footprint, it has historically adopted an efficiency or degrowth model (Ferreboeuf, 2019; Efoui-Hess, 2019; Makonin et al., 2022; Accenture Strategy, 2015; Cunliff, 2020). An analysis of footprinting studies explains how ICT has yet to find a solution for their climate impact. If research designs and their accompanying political debates remain disparate, calculating carbon emissions and implementing effective initiatives to ameliorate environmental consequences will continue to be a challenge. A relational footprinting model that focuses on the relationship between geography, space, technology, and society is a potential solution for this problem. Finding a universal solution for a global infrastructure network whose regulations, climate, and economy varies from place to place should not be the end goal. Rather, leveraging their differences to mitigate emissions using existing sector structures offers an opportunity to reconsider the role between ICT and the environment (Pasek et al., forthcoming). An infrastructural disposition offers an alternative mode of addressing sustainability to keep the planet habitable, information flowing, and business to remain. Thus, my interest in ports and marine technologies in expanding our frame of analysis and sustainability strategies within the

ICT sector. The environmental impact from ports and the Internet's marine basis deserves further investigation. This study begins to bridge that gap to practice a relational footprinting approach to media infrastructure.

Method

To better understand how ports and marine technologies could facilitate the development of a more sustainable ICT sector and subsea cable industry, I conducted interviews with port authorities,port interest organizations as well as subsea cable suppliers and operators of installation and maintenance cables. To begin, I identified a key set of ports around the world that were developing sustainability initiatives. Fifty-five ports along the Pacific coast, the Caribbean, Central and South America, as well as northern and southern Europe were located. Each of these ports reported existing or past sustainability initiatives around alternative energy, carbon emission, particulate emissions, and/or technology advancement. In addition, fifteen port interest organizations were identified, each advocating for ports' sustainability, environmental impact, energy policy, and/or technology development. Background research on these authorities and organizations set the foundation for adapting port technologies to the subsea cable industry.

After initial contact via email, ten authorities and five organizations agreed to an interview. For the port authorities, all interviews were conducted with workers who specifically worked on issues related to sustainability, energy, or the environment. Interviews with port interest organizations were usually with policy experts, researchers, or leadership. Each of these conversations lasted thirty to sixty minutes and focused on the implementation of specific initiatives. This usually followed with inquiries about carbon emissions targets, accounting practices, as well as available and upcoming technology that addresses their sustainability goals. Correspondence with subsea cable industry members exclusively occurred over email. Typically, my questions were asked alongside others pertinent to the sustainability of subsea networks. Learning from members of the cable industry not only provided insights on the possibility of implementing sustainable technology but also on the capacity of collaboration between sectors.

While the aim in these interviews was ultimately to help orient vessel owners in the subsea cable industry to make more sustainable engagement with their choice of ports, all conversations with port industry members addressed the politics and organization of port authorities at some point. In line with an infrastructural disposition, these interactions suggested that sustainability initiatives are best understood in relation to specific geographic, political, technological, and social contexts. Leveraging these specificities made it possible to identify an array of marine technologies that can be applied by the ICT sector broadly and the subsea cable industry in particular. Initially, either sector did not see many connections to the other, suggesting that collaboration is not only beneficial but should be explored to better understand its potential.

Analysis

Like many global sectors, ports are being increasingly pushed to address operational issues that have a negative impact on the environment and have developed emissions reductions goals. Facilities have invested in existing sustainable infrastructures on the port property and have also contributed to research on the feasibility of newer technologies. These investments and developments are not often widely publicized across the marine transport world, so port initiatives remain beyond the view of cable vessel owners and the telecoms industry generally. Increased communication across port authorities and other industries like subsea cables can ameliorate this problem while simultaneously promoting sustainability.

Even though the cable industry isn't tracking what is happening across global ports, marine operators are generally familiar with two of the most frequently adopted and researched technologies: shore power and future energy carriers. Also called onshore power supply (OPS), shore power describes the capacity for ships to plug-in to the electrical grid when docked in port instead of running on their own auxiliary engines (Gutierrez-Romero et al., 2019). "It is always our preference to be on shore power in port, especially when sitting in standby for longer periods of time," says Paul Hebert, Marine Technical Manager at IT International Telecom. This reduces emissions at the port, as well as air pollution. Shore power is not a complete solution to greening marine transport, but it is widely seen as a critical step in the process in improving ecological conditions around the port. “Shore power…absolutely produces emissions benefits,” says Morgan Caswell, Manager of Air Quality Practices at the Port of Long Beach. At least one telecoms cable layer, Orange Marine, has invested in shore power for some of its ships.

Shore power has been suggested as an environmentally sustainable technology and been used for decades. In 2017, the US EPA published a report assessing the technology of shore power. The United States Navy has implemented the use of shore power and suggested it in its Incentivized Shipboard Energy Conservation program (Klemick et al., 2017). The Commission of European Communities published a recommendation on the use of shore-side electricity for ships at berth in community ports in 2006, citing local directives going as far back as 1999. On top of encouraging installation and taking note of the cost-effectiveness of this approach to powering ships, they recommended providing economic incentives, promoting awareness to local authorities, and exchanging best practices across industries to reduce emissions (EU, 2006).

Installing shore power is not as simple as asking vessel carriers to dock and connect to the local grid. Producing effective shore power requires infrastructural installations at the port and the ship itself in order to supply and receive power. Without the parallel investment, nothing can move forward. Thus, partnerships are encouraged so that marine vessels can take advantage of this already existing resource in ways that are conducive for specific ships. Ports are eager to work with carriers whose ships are shore power compatible, but because it is a significant financial incentive, there should be agreements between ports and carriers to invest in this technology. "Making improvements to their vessels to allow for these capabilities can help us as a port," says Alvaro Zayas, Environmental Specialist at PortMiami. "We're not going to make a substantial capital investment in infrastructure if the demand isn't going to be there." At many ports where corresponding infrastructure is in place, vessels that offer shore power receive benefits like priority docking, advantageous time slots, and financial incentives. While shore power was consistently suggested as a sustainable technology among port industry members, it is crucial to maintain clear communication between port operators and vessel carriers to ensure that both parties have the appropriate technology.

Future energy carriers describe the use of alternative fuels with lower lifecycle greenhouse gas emissions. Ports are particularly interested in fuels that are sourced by hydrogen, ammonia, and methanol for bunkering, or the refueling of cargo vessels (Stančin et al., 2020). Future energy carriers are still being researched and are expensive to acquire, but as research progresses and becomes more commercialized, it remains a promising candidate to reduce ship emissions and is a technology of interest in the cable industry.

Future energy carriers are not as commercially accessible as shore power, but ports have made strides in researching the potential use of hydrogen, ammonia, and methanol for bunkering. These three sources are of particular interest because of their efficiency and minimal emissions in their production. Each of them has their weaknesses, so there is no sole solution for alternative energy. Because future energy carriers have different efficiencies according to the infrastructure it seeks to power, using this resource requires just as much knowledge from the cable ship operator as from port terminal operators. “There is discussion but no clear candidate,” says Hector Calls, Head of Environmental Sustainability at the Port of Barcelona. “Probably what will be in the future is a mix, so what we are doing is preparing ourselves with facilities in the port that will accommodate these future fuels that we’ll be transitioning to in the future.” The least renewable form of hydrogen is produced from fossil fuels, but its most renewable form is produced through electrolysis. When electrolysis is conducted using solar or wind energy, it can reduce its emissions even further. Scaling electrolysis for mass production offers a sustainable source for ships, a goal that is possible because of the range of maritime initiatives that research and use green hydrogen (Rosen and Koohi-Fayegh, 2016). As sectors become increasingly pushed to incorporate sustainability goals in their strategic plans, the demand for electrolysis-based hydrogen will increase. Safety and volume concerns surround the use of hydrogen, and regulation is necessary to promote its use among private companies if it continues to be an expensive investment. Collaboration between sectors will promote the use of greener sources of energy, so industries looking to supply their infrastructure with hydrogen, ammonia, and/or methanol are in a position to set the standards for their use in ways that can benefit them, particularly for reducing costs.

Ammonia and methanol are also potential alternative energy carriers, but they have not been explored as much as hydrogen. Commercially made for fertilizers, a renewable ammonia can be made by taking the hydrogen produced from electrolysis and reacting it with nitrogen through a sustainable electrically powered Haber process. Currently, most ammonia is made using a steam methane reforming (SMR) process that emits a significant amount of CO2. Green ammonia is still experimental, but it has the potential to be an even better solution than hydrogen (Hansson et al., 2020). Ammonia does not need to be stored in high-pressure tanks and is a more efficient fuel source for fuel cells. Like hydrogen, there are safety risks when handling ammonia, and it is expensive to produce now.

Along with ammonia, methanol has also been a fuel source of interest for ports. Also known as methyl alcohol, it emits nitrous and sulfur oxides (NOx and SOx) as well as particulate matter, but it can be produced from renewable sources. Methanol is easily accessible, but most of it is produced using natural gas and coal. Blue methanol uses renewable electricity and green hydrogen. A green methanol is possible using renewable energy and sources like biomass (Schorn et al., 2021). There is already a long-standing methanol industry, so much more is known about handling it than hydrogen or ammonia. At the same time, producing blue or green methanol is a difficult process that requires much more research.

As the main gateway for trade, ports are a crucial infrastructure for a further developing globalized economy. They are also an essential infrastructure supporting international telecommunications but are rarely examined in the field. Incorporating ports into studies of internet infrastructure leads us to consider how sustainable marine technologies might be taken up by vessel owners and the subsea cable industry. However, most ports that are in a position to offer these technologies are not regulatory agencies and do not have the capacity to enable vessels to reduce emissions. Thus, my recommendation is to increase communication and cooperation with port authorities through the initiative of the subsea cable industry, for members of the cable industry can set standards informed by their own practices rather than those suggested by those who are not as familiar with the details of operating, maintaining, and repairing cables. Doing so will promote sustainable practices across sectors and help meet emissions targets.

Interviews indicate that the most sustainable ports in the world, particularly in the United States, Canada, and the European Union, are landlord ports and do not engage with vessel owners directly. Many ports around the world are owned by a port authority, public organizations associated with a city, state, or federal government. Landlord ports are those whose governing body rents the port property to terminal operators. Also known as stevedores, terminal operators are responsible for handling cargo equipment, managing dockworkers, loading logistics, and negotiating contracts with vessel carriers (Brooks and Pallis, 2012). The Port of Antwerp-Bruges is such a port, according to Anne-Frédérique Demaerel. “We’re a landlord port, meaning that most of the land around the area is owned by the port authority,” shared the Program Manager for Sustainable Industry. “We give long-term concessions to companies that are willing to use the port area, build installations, and operate them for long periods of time.” However, landlord port authorities have no regulatory power over what vessel owners do beyond what is agreed upon in the lease with the terminal operator. Unless there is regulation or a contract to enforce it, carriers are not required to make the infrastructural changes to reduce their footprint. Efforts to decarbonize marine transport can be further incentivized by companies who use vessels to supply their business like the ICT sector. If the subsea cable industry were to establish these relationships with port authorities, then they could help establish the means by which sustainability is executed to run the Internet.

While most port authorities cannot regulate vessels outside of the port territory, interviews also indicated that these governing bodies are eager to work with ship carriers in reducing their carbon footprint. People who work with ports suggest that carriers communicate their emissions targets and projected infrastructure needs in order for the port to be ready to support them with the corresponding technologies. When asked what vessel owners can do to facilitate sustainable changes at ports, Alex Adams responded, “That relationship and alignment around the type of action and order of action to achieve these shared goals is so easy: just tell us what you need.” Port of Seattle’s Senior Management of Maritime Environmental Programs emphasized that it is in the port’s best interest to make sure their business partners are successful. The organization structure of landlord ports does not usually require the authority to engage with carriers directly, so the best way to make sustainable changes with significant impact will require the port authority, terminal operator, and vessel owner to be in the same room. Ports have their own emissions goals to achieve, and while those that have prioritized sustainability have been able to make advancements in the port property, it is still in their benefit for ships to take up technologies that will reduce emissions overall. The more ports help vessels reduce emissions, the more reduction they can count towards their net-zero goals. In other words, ports are looking for collective efforts to promote sustainability, so the subsea cable industry would benefit from initiating these conversations and ensure that they are maximizing the strategies taken to reach emissions reduction targets. At the same time, it is in ports’ best interest to work with vessel owners in the cable industry to widen their reach and impact.

The most sustainable ports have developed initiatives that enable emissions reduction beyond their jurisdiction. This model may also serve well for the ICT sector in contributing towards a net-zero future in two ways. First, companies across the ICT sector can include reduction targets in their contracts with ship owners and include ship emissions in companies’ carbon accounting. Second, the subsea telecommunications cable industry can consider ways to implement marine technologies within their own operation. Rather than thinking of ports as governing bodies without any regulatory power, the ICT sector can leverage their efforts to decarbonize marine transport by encouraging ships owned by subsea cable companies to take up the most sustainable technologies available. Indeed, a bilateral relationship between both sectors will make reaching sustainability goals easier at a lesser cost.

Interviews with port authorities around the world also suggest that there will likely be no single solution to decarbonize marine transport. Instead, ship carriers should expect to use a range of strategies according to their vessel, voyage, and regulations. "It's not solely a matter of fuel change to achieve improvements on vessels' footprint," says Calls. "It's also a matter of engine technology, vessel design, voyage optimization, power systems, and alternative propulsion technologies…Of course, fuel use and carbon capture are the most important ones, but there are others that can be quite important as well where even more significant results can be achieved." Reducing emissions will require multiple strategies to be implemented at the same time to optimize a specified journey. Telecoms would benefit from a similar approach, incorporating a variety of different technologies across its operation according to its specified production. When I say that companies across the sector should include reduction targets in their contracts with ship carriers, I mean to say that the industries that utilize marine vessels like subsea cables should include vessel emissions when accounting for their company's greenhouse gas emissions. There are different tools available for ports to work with stakeholders, particularly through contractual agreements and professional relationships. For example, ports may have a lease agreement with terminal operators that they can use to advance their environmental goals. Those agreements can include environmental covenants that ask lessees to take specific actions to improve air quality. When ports don't have contracts, they use their professional relationships to collaborate on a voluntary basis. Contracts can establish agreements between ship carriers and companies to reduce emissions that count toward net-zero calculations. Ports can function as facilities that are equipped to support ships in adapting and supporting marine technologies. There may not be a single solution to decarbonize marine transport, but understanding that several strategies may be necessary to reduce emissions demonstrates that multiple actors across a range of sectors can work together to build a global sustainable infrastructure network.

Results

Engaging with people who work on issues related to the environment and energy at ports reminds us of the substantial contribution to carbon emissions that results from marine transport. They highlight the necessity and benefit for sectors to work across industries to reduce emissions and reach their sustainability goals. Working together requires good communication through transparent data and trust. “Relationships are one way where we can figure out how to make action happen,” Adams says. “Recognizing that one port is its own global ecosystem. We think a partnership approach might be helpful in finding common ground to set common milestones with other ports of call.” I think that this can also be applied across the ICT sector, particularly for the subsea cable industry and others who depend on marine vessels to function.

At the same time, speaking to members of the cable industry also demonstrates that, like ports, they are also adapting an array of solutions that collectively helps reduce emissions. Many of these initiatives are informed by practices taken up by other sectors. Companies like IT International Telecom in Halifax, Nova Scotia are already operating with alternative fuels, such as Ultra Low Sulphur Marine Gas Oil (MGO), which reduces air pollution compared to Marine Diesel Oil (MDO) or Heavy Fuel Oil (HFO). An interview with Stephen Arsenault, Director of Global Submarine Solutions at IT International Telecom furthers this use of future energy suppliers, “Two of our three ships are powered by diesel-electric propulsion systems. This allows for better load pairing of the appropriate number of generators online for the given load, where each generator set is run in its optimum power range for efficiency." Beyond replacing low efficiency light fixtures with marine LED fixtures and separating waste oil from bilge slops in drums to use for lubricant base stock or industrial fuel, "All auxiliary machinery onboard, cable equipment and subsea equipment are driven by electric power, and not direct-engine driven." These multiple solutions that have been taken up by subsea cable marine vessel owners could also have a significant impact on how port authorities approach sustainability as well. Given that both industries are adopting a multi-pronged approach to sustainability, increased communication and collaboration could enhance already existing solutions in ways that avoid having to constantly build and pay for new technology.

The subsea cable industry depends on marine vessels to transport the materials and maintain the infrastructure necessary to operate the Internet. At first glance, the connection between ports and telecommunications may not seem apparent, but the global development of sustainable information and communication technology is dependent on the transportation of materials made possible by marine vessels. Telecoms can contribute to a more sustainable future by enabling ship carriers across their supply chain and within their own industries to take up sustainable marine technologies. Port sustainability initiatives and management structure lead us to viable technologies for marine vessels. Many of these technologies could also be used by ICT companies along their system of operation. In the case of the subsea cable network, there are certain technical changes that would be more realistic for vessels to take up than others, and there are others that could be used to operate cable landing stations (CLS). Governing bodies, private companies, and vessel owners can work together to reduce emissions. Therefore, I argue that increased collaboration across the port and subsea cable sectors can further sustainability efforts, specifically carbon emissions reduction, through mutual financial investments in marine vessel technologies. Coordinated efforts in sustainability minimize the risk of experimental technologies by maximizing on already existing resources. In this way, everyone involved benefits from adopting green practices. The technologies I suggest below are ones that would be best implemented through collaboration with ports in particular.

Marine Technologies to Decarbonize Marine Transport

Port authorities around the world are planning and executing initiatives that explore the capacity for sustainable technologies to be taken up in their facility. Many are promising in contributing to a net-zero carbon emissions future for marine transport at large. ICT companies who work with marine vessels should incentivize their carriers to take up these technologies. While shore power and alternative fuel sources are leading the way at ports through their initiatives, voyage optimization and carbon capture are also promising candidates for decarbonization.

Voyage optimization aims to increase energy efficiency by using a combination of technologies and analytics. Vessel speed reduction (VSR) is a form of voyage optimization, where ships aim to maximize their emissions reduction as well as arrival time. Emissions are reduced solely by slowing down speed in the port region. This minimizes the amount of fuel used, which has financial benefits, and it reduces ozone for communities living in the area as well (Khan et al., 2012). Ports like Los Angeles, San Diego, and New York/New Jersey require ships within twenty to forty nautical miles of the port to reduce their speeds between ten and fifteen knots. For voyage optimization to contribute to decarbonization, multiple strategies and areas of focus must be considered. Thus, solutions like engine technologies and voyage optimization are recommended to be executed in tandem with other initiatives and projects.

Carbon capture and storage (CCS) describes the process of separating carbon dioxide from the emissions of industrial processes before it is released into the atmosphere and stored deep underground. CCS allows for the industry to operate in a way that reduces greenhouse gasses, but storage has been difficult to locate because it must be safe, environmentally sustainable, and cost-effective (Al Baroudi et al., 2021). This solution may be appealing to vessel owners because suitable storage can occur in onshore and offshore locations. The Port of Antwerp-Bruges has been researching CCS along with utilization (CCUS) for over ten years. “It allowed us to investigate what was technical, feasible, and economical for large emitters to capture carbon, transport it within the port area, and export it towards carbon production facilities or to use it for future processes,” said Demarael. Developing the technology and maintenance to capture and store CO2 can allow the subsea industry to reduce atmospheric emissions. CCU projects have reduced more than 1 million metric tons of CO2 emissions per year, and more than 200 CCU operations have been completed in the world (US DOE, n.d.). Ships with more heat waste are better candidates for CCS, but capital and operating costs are high. CCS uses already-existing technologies that are being developed on their own, so if their costs can be addressed, it remains a useful technology (Stena Bulk, 2021).

Marine Technologies for the Subsea Cable Industry

The use of sustainable marine technologies should also be considered within the ICT sector. The subsea industry, in particular, has an aging fleet that is not likely to be replaced soon. Thus, retrofit power assistance technologies like sails and fuel cells may be of particular interest. Power assistance describes the broad measures that can be harnessed to reduce main engine power and provide an auxiliary power source to reduce greenhouse gas emissions. The capacity for emissions reduction ranges across these strategies, but a combination of these along with other sustainable technologies can be substantial. If companies are unable to incentivize the carriers they work with or do not require the use of vessels directly, they may still be able to employ these strategies in other stages of their operation.

Power kites harness the wind's energy at high altitude and are being applied at the industrial level (Musa et al., 2011). These systems comprise of controlled power kites that gain altitude in figure-eight paths, unwinding a tether from the ground whose force drives a generator that produces electricity. Once the winch has unwound the tether to its maximum extension, the kite is steered onto a position that minimizes drag and lift to reel in the tether using a fraction of the energy generated during the initial phase. These models fly at altitudes ranging from 200 to 400 meters, and they can feed energy to the grid, store it in batteries, or consume it directly. For marine vessels, a control computer operates the propulsion system, and an autopilot software uses wind direction and velocity as well as vessel velocity to guide the kite through a pattern of optimal propulsion (SkySails, 2022). A 5,400-square-foot kite system has been installed on a 505-foot-long cargo ship that sailed back and forth between Europe and North America between December and June (Brandon, 2022). Equipping 15% of the world's commercial fleet with kite systems could result in up to 40 million tons of CO2 emission reduction (Seawing, n.d.).

Fuel cells describe energy sources that use hydrogen or other fuel sources to produce clean electricity. For the subsea cable industry, they can be used to power cable landing stations (CLS), but their flexible and efficient use makes it a promising candidate to reduce emissions for telecoms at large. They have been used for primary and backup power for commercial, industrial, and residential buildings as well as vehicles like forklifts, automobiles, and boats (Allen et al., 1998). This technology functions like a battery, but it doesn't need to be recharged to extend its functionality. If the cell has fuel, it will continue to produce electricity, along with heat and water (FCHEA, 2022). The greenhouse gas intensity and other environmental impacts of fuel cells depend on both the production of the infrastructure as well as the fuel. While the technology for hydrogen fuel cells already exists and is being used, manufacturing it requires the use of fossil fuels. Fuel cells have the capacity to increase their overall efficiency because they can be located on site and their heat can be used for other purposes (Welaya et al., 2011).

Fuel cells can be useful for the subsea cable industry to power cable landing stations, yet much more research has been explored on their capacity for use in vessels. A 2020 study by Sandia National Laboratories demonstrated that hydrogen fuel cell propulsion technology could be used for a coastal/local research vessel that presented significant advantages compared to using a battery in terms of emissions, efficiency, and pollutants (Klebanoff et al., 2020). They also published a study presenting designs for passenger vessels that are powered solely by fuel cells. All designs are feasible today, demonstrating that “low speed, large capacity vessels offer a cost-effective starting point for today’s hydrogen fuel cell technology” (Pratt and Klebanoff, 2018). The technology already exists, is scalable, and can be a zero-emission solution. While it may not be the sole solution, fuel cells present a transition technology that can be used alongside other sustainable solutions to work towards net zero.

There are several options for reducing marine vessel emissions available, and ports are eager to support ship carriers in their sustainability goals since it also benefits operators and authorities. Retrofitting existing vessels is better and cheaper than building and buying new ships, but doing so still requires a significant amount of money. Therefore, mutual collaboration between sectors will further sustainability in ways that minimize expenses. "The investment in new port facilities and greener vessels is expensive for both port operators and vessel owners but eventually it is something that will have to be done,” said Global Marine CEO Bruce Neilson-

Watts. “The key to success though is ensuring all stakeholders communicate their needs/wants, port owners to communicate their future green energy roadmap as this assists ship owners to make more informed decisions on newer propulsion technology.” As setting carbon emissions targets and executing sustainability initiatives continue to become required and necessary, all industries working with marine vessels will need to consider how to minimize their impact. Because more and more sectors will need to adapt green practices, it will be much easier, efficient, and cost-effective if companies collaborated with one another, across the supply chain, to take up technologies that support these goals. Building ties across port authorities and the subsea cable industry will only help both parties make better informed and environmentally conscious decisions. “Where possible we want to avoid port owners investing in fuelling infrastructure that is not aligned with shipowners future vessel investment plans,” Neilson-Watts shared. Collaboration across sectors will allow companies to take action quickly in ways that are cost-efficient and can be scaled depending on their results.

Conclusion

The ICT sector is being pushed to be more sustainable. Thinking about subsea cables as part of the global internet telecommunication network requires the use of vessels that contribute to maritime transport greenhouse gas emissions. Ports guide us to marine technologies that can help the subsea cable industry be more sustainable. Telecommunications companies should leverage their relationships with ship carriers and incentivize them to adopt these technologies. In addition, the industry should consider ways to use energy efficient technologies across their own operation. Adopting an infrastructural disposition to telecommunications helps us think of the broad ways in which the myriad material byproducts of our media and communications network are produced. Doing so leads us to collaborate across industries to support decarbonizing efforts by using sustainable technologies in ways that are specific to a network of infrastructure and informed by their geographic, spatial, political, and social contexts.

Our global telecommunications network is dependent on marine transport and is also being pushed to be more sustainable. One way of leveraging this need to be environmentally conscious within ICT is by establishing business agreements with transport companies to do their best to be shore power compatible, adopting alternative fuels, and working with ports to receive support. I strongly recommend for port authorities and the subsea cable industry to adopt shore power technology in their sustainability plans specifically, particularly because it is already being used successfully across both sectors and has proven to reduce emissions. "We plug into shore power wherever possible and when the power provided is compatible with the electrical requirements of our ships," said Stephen Arsenault of IT International Telecom. The company currently uses on shore power at their Halifax, Nova Scotia marine operations and cable, and they work with Detyens Shipyard in North Carolina, USA as well as Port Alberni in British Columbia, CA. "It is always our preference to be on shore power in port, especially when sitting in standby for longer periods of time." If shore power or future energy carriers are not possible, industries like the subsea cable industry, who depend on a marine fleet to lay, maintain, and repair their systems, can retrofit their existing vessels to use power assistance technologies and consider ways to use them along their operation like in cable landing stations. Not only will this help reduce greenhouse gas emissions, but it will also do so in ways that are specific to the type of vessel used, where existing infrastructure exists, and what regulations are set in place. Doing so will be more efficient, effective, and cost effective if marine vessels used these technologies in collaboration with port authorities. There may not be one solution to decarbonizing marine transport, but thinking about emissions in a relational way through the specificity of sustainable ports reminds us that we can use the resources that are already available.

It is not necessary to replace a fleet for subsea cable installation or maintenance companies to decarbonize their operation. Companies can take up practices like Global Marine has for subsea cables to contribute their part in emissions reduction. Adopting shore power is significant, though their business serving offshore renewables and offering voyage optimization also contributes to reducing their carbon footprint. “The truth is most major ports do offer shore power, but it’s usually limited to/reserved for cruise liners, ferries, large cargo ships, and the like,” said Arsenaut. “Cable ships are typically given berths away from those main areas, without shore power access.” As effective as shore power is, this proves that companies cannot depend on a one-size-fits-all solution, so it is imperative that the subsea cable industry collaborate with ports and other sectors to further expansion of already existing sustainable technologies. Given their significant emissions, any contribution towards ships’ reduction helps. Working across operation centers and ports would also allow for us to develop better accounting practices because of their local specificity. As sustainability continues to be a growing concern for Internet use, thinking about infrastructure, environment, and collaboration together in geopolitical contexts appears to be the best way to advance the ethical development and use of ICT.

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